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The Emergence of Baryon Asymmetry of The Universe

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Abstract

This paper explains the cause of spontaneous symmetry breaking, which led to the emergence of baryon asymmetry in the future universe, using the mechanism of gravity inherent in the general formula for gravitational force. The results obtained are used to calculate the baryon number. This calculation is used to analyze the formula for gravitational force in three-dimensional space, which can be expressed in terms of the concentrations of baryons, antibaryons, and photons. Using the photon concentration formula, gravitational force is represented through the elastic force that arises in three-dimensional space due to the influence of the four-dimensional gravitational force exerted by a five-dimensional sphere.

Keywords: gravitational force, 5-dimensional sphere, baryon mass, antibaryon mass, Friedman equation; 3-dimensional time, 3-dimensional volume, baryon number, concentration

1. Introduction

Baryon asymmetry in the Metagalaxy refers to the predominance of baryonic matter over baryonic antimatter. This conclusion is based on experimental searches for annihilation photons. The asymmetry is measured by the baryon dimensionless number, which indicates the excess of baryons over antibaryons, divided by the photon concentration. This number has been calculated solely based on experimental data. It characterizes the baryon charge of the universe, or cosmic baryogenesis. Its derivation from fundamental theory remains a problem. There are three approaches to explaining the excess of particles over antiparticles. The first is that the excess arose in the universe from the very beginning. The second is that the Metagalaxy consists of an equal number of regions-domains-some containing particles and others containing antiparticles, but overall, charge symmetry is preserved. The third approach suggests that the baryon charge is not fundamental and must be derived from the general laws of physics. This third approach is currently being actively developed. It is based on the assumption that the number of baryons and antibaryons was strictly symmetrical from the very beginning, and the excess arose early in the development of the Metagalaxy through evolution. The main condition for the emergence of baryon charge is considered to be proton instability. The calculated baryon charge values according to this approach lie within the range of, i.e., have a wide range. The author adheres to the first approach in explaining the asymmetry of the Metagalaxy. The conclusion is based on proof of the asymmetry of the Universe due to the spontaneous breaking of time symmetry.

2. The Cause of Spontaneous Symmetry Breaking

In the author's work [1], the second part of Newton's law of universal gravitation was derived. It is as follows:

$$F_{гр} = -\frac{M_{пр} M_{гр} G}{l^2} = \frac{\frac{8\pi^2}{3} l_я^4 (p_{пр} - p_я)}{\frac{1}{2}(4\pi l^2 - 4\pi l_я^2 \cdot \frac{l_я}{l})} \quad (1a)$$

Here: $M_{пр}$ is the test mass that is attracted to the gravitational mass $M_{гр}$;

l- the distance between masses in 3-dimensional space;

$l_я = \frac{M_{гр}G}{c^2}$ - gravitational radius of the core from the gravitational mass;

$\rho_{пр}c^2 = p_{пр}$ - gravitational pressure created by the test mass;

$p_я = \rho_я c^2 = \frac{M_{пр}M_{гр}G}{\frac{8\pi^2}{3}l_я^4}$ - pressure from the density of the gravitational core, which has the shape of a 5-dimensional sphere; $8\pi^2 l_я^4 / 3$ - surface area of a 5-dimensional sphere.

The gravitational force occurs in three-dimensional space. Its second part is derived from the formula for the resultant force occurring in a five-dimensional sphere. It has the form:

$$F_p = \frac{2}{3}l_я^2(\rho_{пр} - \rho_я)c^2 = \frac{F_{гр}}{2\pi l_я{}^2}(\frac{l^3 - l_я^3}{l}) \quad (1b)$$

It's this formula that interests us. It connects gravity in a 5-dimensional sphere with gravity in a 3-dimensional ball. Far-reaching conclusions follow from this connection. To substantiate them, we'll use the ratio of forces:

$$\frac{F_p}{F_{гр}} = \frac{\frac{2}{3}l_я^2(\rho_{пр} - \rho_я)c^2}{F_{гр}} = \frac{1}{2\pi l_я{}^2}(\frac{l^3 - l_я^3}{l})$$

Where

$$l^3 - 2\pi l_я{}^2 l \frac{F_p}{F_{гр}} - l_я^3 = 0 \quad (2)$$

Let us apply the theory of 3-dimensional time [2], developed by the author, to the resulting equation. We will associate the resulting formula with the spatial coordinate of the vertical hyperplane, which is the third coordinate in the coordinate system of 3-dimensional time.

$$\tilde{l} = \frac{l^3}{l_я^2} = \frac{ls}{l_я} \quad (3a)$$

Where

$$s = \frac{l^2}{l_я} \quad (3b)$$

is the proper time of the duration vector.

The resulting formula is the equation of a hyperbolic paraboloid, which is the geometry of 3-dimensional duration time. Then formula (2) can be written as:

$$l_я{}^2(\frac{l^3}{l_я{}^2} - 2\pi l \frac{F_p}{F_{гр}} - l_я) = 0$$

Or

$$\tilde{l} - 2\pi l \frac{F_p}{F_{гр}} - l_я = 0$$

Where

$$\tilde{l} = \frac{ls}{l_я} = 2\pi l \frac{F_p}{F_{гр}} + l_я \quad (4)$$

Thus, we obtained a linear relationship between the spaces of the vertical and horizontal hyperplanes.

Let's express the resulting formula in terms of the proper time belonging to both hyperplanes:

$$\frac{ls}{l_я}\cdot\frac{l_я}{l}=s=(2\pi l\frac{F_p}{F_{гр}}+l_я)\cdot\frac{l_я}{l}=2\pi l\frac{l_я}{l}\frac{F_p}{F_{гр}}+l_я\frac{l_я}{l}=2\pi l_я\frac{F_p}{F_{гр}}+\frac{l_я^{\,2}}{l} \quad (5a)$$

Let's express it through dimensionless coordinates *x, y*

$$x=\frac{s}{l_я}=2\pi\frac{F_p}{F_{гр}}+\frac{l_я}{l}=2\pi\frac{F_p}{F_{гр}}+\frac{1}{\frac{l}{l_я}}=2\pi\frac{F_p}{F_{гр}}+\frac{1}{y} \quad (5b)$$

where $y=l/l_я$

The graph of the function is shown in Fig. 1 with the ratio of forces equal to one.

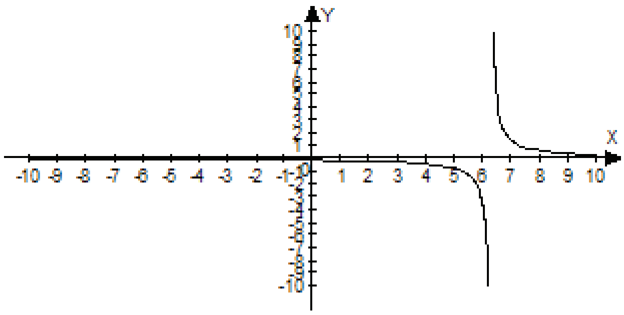

Fig. 1 Graph of the function $x=f(y)$ at $F_p=F_{гр}$

The coordinate of the intersection point can be found by solving the function at *x=0*. At the same time

$$y=-\frac{F_{гр}}{2\pi F_p}=-\frac{1}{2\pi}=-0{,}159154943 \quad (6)$$

As we see, a zero time value corresponds to a non-zero negative spatial coordinate. This fact indicates a spontaneous symmetry breaking between time and space in the horizontal hyperplane when the gravitational and net forces are equal.

Let us show that equation (2) can be reduced to the Friedman-Einstein equation.

We transform:

$$0=l\cdot l_я^{\,2}(\frac{l^2}{l_я^{\,2}}-2\pi\frac{l_я^{\,2}}{l_я^{\,2}}\frac{F_p}{F_{гр}}-\frac{l_я^3}{l\cdot l_я^{\,2}})=l\cdot l_я^{\,2}(\frac{l^2}{l_я^{\,2}}-2\pi\frac{F_p}{F_{гр}}-\frac{l_я}{l})$$

We bring it to the form by multiplying both parts c^2:

$$u_p^2=c^2\frac{l^2}{l_я^{\,2}}\pm c^2+\frac{2l_я}{l}c^2=2\pi\frac{F_p}{F_{гр}}c^2+\frac{3l_я}{l}c^2\pm c^2 \quad (7)$$

Let's connect the right side with the time formula (5b):

$$\frac{s}{l_я}=2\pi\frac{F_p}{F_{гр}}+\frac{l_я}{l}=2\pi\frac{F_p}{F_{гр}}+\frac{3l_я}{l}-\frac{2l_я}{l}-1+1$$

Or

$$c^2\frac{s}{l_я}\pm c^2+\frac{2l_я}{l}c^2=2\pi\frac{F_p}{F_{гр}}c^2+\frac{3l_я}{l}c^2\pm c^2=c^2\frac{l^2}{l_я^{\,2}}\pm c^2+\frac{2l_я}{l}c^2=u_p^2 \quad (8)$$

where u_p^2 - the square of the expansion rate of the Universe.

If we reduce the terms, we arrive at the time formula (3b):

$$c^2 \frac{s}{l_я} = c^2 \frac{l^2}{l_я^{\ 2}}$$

As we see, the equation consists of two parts. The first part is the Friedman equation, derived from General Relativity. The second part is also equal to the square of the expansion velocity. It is not part of the classical equation, but is a consequence of the transformation of the resultant force in a 5-dimensional sphere. If the Friedman equation is limited by the first part, then various solutions are possible, leading to the main models of the universe's development. Friedman obtained these, and they form the basis for the development of the modern Big Bang theory.

We will demonstrate the transition to the form of these equations.

We will express the radius of the nucleus through the formula for the gravitational radius.

$l_я = M_я G / c^2$, given in the formula for the gravitational force. By the mass of the nucleus, $M_я$ we mean the mass of matter, which exactly corresponds to the mass of antimatter. For the first term of the equation, we introduce the notation of the cosmological constant $\Lambda_я$:

$$\frac{c^2}{l_я^{\ 2}} = \Omega_я^2 = \frac{\Lambda_я c^2}{3}$$

It is expressed through angular velocity $\Omega_я$ and, at the same time, can be expressed through vacuum density $\rho_я$.

$$\Omega_я^2 = \frac{c^2}{l_я^{\ 2}} = \frac{c^2 l_я}{l_я^{\ 3}} = \frac{M_я G}{l_я^{\ 3}} = \frac{M_я G}{\frac{4}{3}\pi l_я^{\ 3}} \frac{4}{3}\pi \frac{c^2}{c^2} = \frac{\rho_я \frac{4}{3}\pi G c^2}{c^2} = \frac{1}{3} \cdot \frac{4\pi \rho_я G}{c^2} c^2 = \frac{1}{3}\Lambda_я c^2 \qquad (9)$$

Where $\Lambda_я = \frac{4\pi\rho_я G}{c^2}$ there is a cosmological constant from a 3-dimensional spherical vacuum.
Then equation (7) can be written as:

$$u_p^2 = \frac{1}{3}\Lambda_я c^2 l^2 - c^2 + \frac{2M_я G}{l} = c^2 \frac{s}{l_я} - c^2 + \frac{2M_я G}{l} = F_0 \frac{s}{M_я} - c^2 + \frac{2M_я G}{l} \qquad (10a)$$

Where $c^2 \frac{s}{l_я} = c^4 \frac{s}{M_я G} = F_0 \frac{s}{M_я}$ is the specific energy of proper time.

To get directly to the energies, we multiply both sides by the mass $M_я = M_б = M_{а.б}$, which is equal to the baryonic mass of matter and the anti-baryonic mass of antimatter. Then the equation takes the form:

$$M_я u_p^2 = M_б \frac{1}{3}\Lambda_я c^2 l^2 - M_б c^2 + \frac{2M_б G}{l} M_б = F_0 s - M_{а.б} c^2 + \frac{2M_б G}{l} M_{а.б} \qquad (10b)$$

The left side of the equation $\Lambda_я$ is the energy of baryonic matter. The right side of the equation is the energy of antimatter.

The first term, which includes, describes the vacuum formed by the mass-energy of antimatter.

The third term is the second cosmic gravitational velocity, formed by the baryonic mass of matter. The algebraic addition of the three terms yields the specific energy of the Universe, consisting of matter and antimatter of equal mass. It is logical to assume that this energy is the basis for the evolution of the Universe.

By expressing the square of the velocity through the derivative $u_p = dl / dt$, Friedman obtained his famous equation. He couldn't have done otherwise, since Einstein's tensor equation for the gravitational field yielded no other terms. In deriving the equation, the second cosmological postulate was modified: The three-dimensional space of the Metagalaxy is isotropic and homogeneous. This isotropy is preserved regardless of the observation point. Furthermore, the derivative with respect to time was used as a parameter. The nature of time had not been studied. It was imagined as a straight ray directed from the past to the future.

The resulting equation (10a) has a second part of the specific energy. It can be interpreted as chronal energy, or proper-time energy, interacting with the second gravitational velocity arising from the mass of matter. Such interaction is possible in a 5-dimensional sphere. It leads to the equilibration of the energy contained in 3-dimensional space.

Let the mass of matter interact with the mass of antimatter in 3-dimensional space according to Newton's law of gravitation. Their interaction occurs with the same magnitude of force F_p in a 5-dimensional sphere. The sphere exerts an influence on the conglomerate in the form of 3-space.

Thus, between the two equal masses, a force equation holds in the form:

$$F_{гр} = F_p = -\frac{M_б \cdot M_{a.б} \cdot G}{l^2} \quad (11)$$

Equality of forces generates equality of energies for both types of mass. In general, equality of energies is described by equation (10b). Equality would hold if symmetry were maintained with respect to the proper time axis. This means that this axis would have no connection with space and would be represented as a straight line, i.e., would be expressed as a parameter, which is a scalar quantity. In this case, the equality of specific energies would not lead to a non-stationary universe. However, the problem is that 3-dimensional space is immersed in a 5-dimensional sphere, in which time is a nonlinear quantity described by a parabolic function. This nonlinearity disrupts the asymmetry of time relative to the positive spatial axis *l*, where the mass of matter was located, and the negative spatial axis (-*l*), where the mass of antimatter was located.

It was expressed in the fact that the zero moment of time did not correspond to a zero spatial interval. As shown by formula (6), the meeting point of specific energies had coordinates (0, -0, 159154943). The second coordinate is close to zero, but not equal to it. This inequality disrupted the equilibrium between the energies, and they began to interact through annihilation. As a result, equality (10b) was violated. This led to function (5b) becoming parabolic, which resulted in a cubic equation at $F_p = F_{гр}$.

$$x = \frac{s}{l_я} = \frac{l^2}{l_я^2} = y^2 = 2\pi + \frac{1}{y}$$

Where $y^3 - 2\pi y - 1 = x = 0$ and $\frac{l^3}{l_я^3} - 2\pi\frac{l}{l_я} - 1 = 0 = \frac{s}{l_я}$ (12)

Its solution is three roots:

$$(\frac{l}{l_я})_1 = -2,4229\,; \qquad (\frac{l}{l_я})_2 = -0,15852 \qquad (\frac{l}{l_я})_3 = 2,58271 \quad (13)$$

These data show that the second root is very close to the coordinate of the point where the masses meet (-0, 159154943). This suggests that it was this negative shift that led to the second root, which then became the cause of the other two roots. The graph of the cubic parabola is shown in Figure 2.

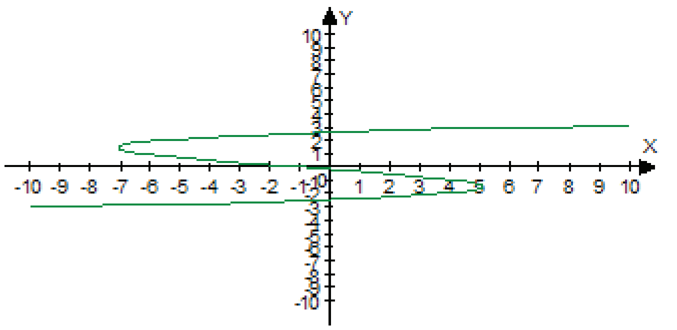

Fig. 2 Graph of a cubic parabola.

3. Definition of Cosmic Baryon Number

The resulting root values can be used to determine the cosmological baryon number, indicating that the number of baryons exceeds the number of antibaryons. According to one hypothesis, this excess exists in nature from the very beginning, i.e., the Metagalaxy emerges sharply antisymmetric with respect to particles and antiparticles.

The excess of particles over antiparticles is a fundamental constant of nature. This hypothesis has merit, but one significant question remains: when should we consider the beginning of the Metagalaxy's formation? In the case under consideration, the processes that led to the initial equality of specific energies are unknown. The origin of the baryonic masses of matter and antimatter is also unknown. It is known that this equality was violated when proper time was taken as zero. This moment will be considered the beginning of the formation of the resulting three-dimensional space of the Metagalaxy, with the masses of matter and antimatter already present within it.

The first two roots result in two negative radii. They can be represented as concentric circles with a common center. The third root is positive and results in a circle with the same center. Each circle can be divided into a certain number of energy levels, represented as concentric circles. The first two circles, each with a negative radius, have energy levels with negative energy. The circle with a positive radius has energy levels with positive energy. The superposition of circles with a common center leads to the quenching of the energies in the levels. However, complete quenching does not occur. There remains slightly more positive energy than negative. It takes the form of a three-dimensional spatial sphere. The baryonic mass is concentrated in the center of the sphere, and the antibaryon mass is concentrated at the periphery. A schematic diagram of the process is shown in Fig. 3.

Let us prove this by adding all three dimensionless radii algebraically:

$$\frac{\Delta l_0}{l_я} = \sum_1^3 \left(\frac{l}{l_я}\right) = \left(\frac{l}{l_я}\right)_1 + \left(\frac{l}{l_я}\right)_2 + \left(\frac{l}{l_я}\right)_3 = -2,4229 - 0,15852 + 2,58271 = 1,29 \cdot 10^{-3} \qquad (14a)$$

From where we find the positive radius of a 3-dimensional ball, which contains positive energy.

$$\Delta l_0 = 1,29 \cdot 10^{-3} l_я \qquad (14b)$$

We raise it to a cube.

$$(\Delta l_0)^3 = (1,29 \cdot 10^{-3})^3 l_я^{\ 3} = 2,146689 \cdot 10^{-9} l_я^{\ 3} \qquad (14c)$$

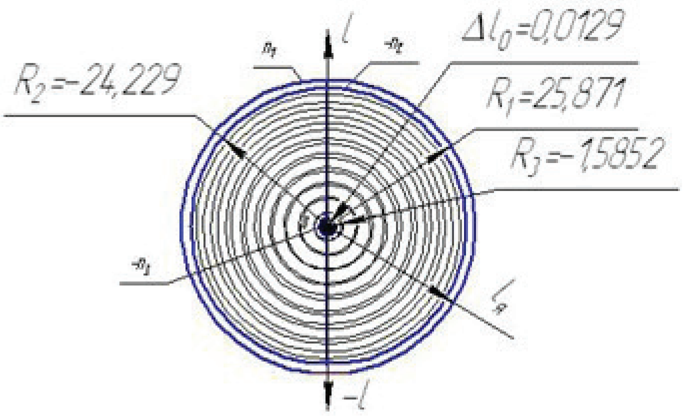

Fig. 3. Energy levels with positive and negative energy.

For further study, we equate the resulting volume found (14c) to its ellipsoidal volume of revolution:

$$(\Delta l_0)^3 = (2,146689 \cdot 10^{-9} l_я^{\ 3} = \frac{4\pi}{3} B l_я^{\ 3} = \frac{4\pi}{3} l_я^{\ 2} \cdot B l_я \qquad (14d)$$

where B is the cosmological baryon number, which indicates the asymmetry of the resulting volume due to the absence of a antiparticle's in it.

From the resulting equation we find B:

$$B = \frac{(\Delta l_0)^3}{\frac{4\pi}{3} l_я^{\ 3}} = \frac{(2,146689 \cdot 10^{-9}) l_я^{\ 3}}{\frac{4\pi}{3} l_я^{\ 3}} = \frac{3}{4\pi}(2,146689 \cdot 10^{-9}) = 5,124844748 \cdot 10^{-10} \qquad (15)$$

The found value of the baryon number is in good agreement with the experimental value $B \simeq 6 \cdot 10^{-10}$ presented in the article [3].

The resulting number participates in the formation of the primary 3-dimensional volume containing baryonic matter. We will examine this process. The 3-dimensional volume is related to the force of gravity in 3-dimensional space, determined by formula (1a).

We take the baryonic mass as the gravitational mass $M_б$. As a tentative mass, we choose the antimatter mass $M_{а.м}$. Then the force will be written as:

$$F_{0гр} = -\frac{M_{а.б} \cdot M_б G}{\Delta l_0^2} \qquad (16)$$

The gravitational baryonic mass and antimatter mass correspond to an initial three-dimensional volume, expressed in terms of the initial baryon time. These types of mass exist in the same volume, but each in its own time. The condition force their existence is written as:

$$\Delta l_0{}^3 = \frac{9}{2} M_б G t_{0б}^2 = \frac{9}{2} M_{а.б.} G t_{0а.б.}^2 \tag{17a}$$

Let's write the volume in terms of the gravitational radii of both types of mass: $P_б = P_{а.б.} = l_я$

Equating it to (14d), we obtain the equation:

$$\Delta l_0{}^3 = \frac{9}{2} P_б c^2 t_{0б}^2 = \frac{9}{2} P_{а.б.} c^2 t_{0а.б.}^2 = \frac{4\pi}{3} l_я{}^2 \cdot B l_я \tag{17b}$$

Where

$$l_я{}^3 = \frac{3}{4\pi B} \Delta l_0{}^3 = \frac{\Delta l_0{}^3}{2,146689 \cdot 10^{-9}} = 465833662,9 \Delta l_0{}^3$$

Taking the cube root, we get:

$$l_я = \sqrt[3]{\frac{\Delta l_0{}^3}{2,146689 \cdot 10^{-9}}} = 0,77519379 \cdot 10^3 \cdot \Delta l_0 = 775,1937984 \Delta l_0 \tag{17c}$$

Let's consider the equation for antimatter (16b). Divide by $4\pi l_я{}^3 / 3$:

$$\frac{\Delta l_0{}^3}{\frac{4\pi}{3} l_я{}^3} = B = \frac{\frac{9}{2} M_{а.б.} G t_{0а.б.}^2}{\frac{4\pi}{3} l_я{}^3} = \frac{9}{2} \frac{M_{а.б.}}{\frac{4\pi}{3} l_я{}^3} G t_{0а.б.}^2 = \frac{9}{2} \rho_{0а.б.} G t_{0а.б.}^2 \tag{18a}$$

Where $\rho_я = \rho_{0а.б.} = \dfrac{M_{а.б.}}{\frac{4\pi}{3} l_я{}^3}$ - initial density of antimatter.

It depends on the number :

$$\rho_{0а.б.} = \frac{2B}{9 G t_{0а.м.}^2} \tag{18b}$$

We'll do a similar operation with equation (16b) for baryonic matter.

Divide by $4\pi l_я{}^3 / 3$ and substitute the resulting value $l_я{}^3$

$$\frac{\Delta l_0{}^3}{\frac{4\pi}{3} l_я{}^3} = B = \frac{\frac{9}{2} M_б G t_{0б}^2}{\frac{4\pi}{3} l_я{}^3} = \frac{9}{2} \frac{M_б}{\frac{4\pi}{3} l_я{}^3} G t_{0б.}^2 = \frac{27}{8\pi} \frac{M_б}{\frac{3}{4\pi B} \Delta l_{0e}^3} G t_{0б.}^2 = 6\pi B \cdot \frac{M_б}{\frac{4\pi}{3} \Delta l_{0e}^3} G t_{0б.}^2 = 6\pi B \cdot \rho_{0б} G t_{0б.}^2$$

Where $\rho_{пр} = \rho_{0б} = \dfrac{M_б}{\frac{4\pi}{3} \Delta l_{0e}^3}$ - is the initial density of baryonic matter.

Reducing by B, we get:

$$\frac{B}{B} = 1 = 6\pi \cdot \rho_{0б} G t_{0б.}^2 \text{ or } \rho_{0б} = \frac{1}{6\pi \cdot G t_{0б.}^2}$$

Thus, the baryon density, unlike the density of antimatter, does not depend on the baryon number.

4. The Role of Gravity in Baryon Asymmetry

After the formation of the resulting 3-dimensional volume, the ratio of gravitational forces is no longer equal to unity. Therefore, the resulting force is determined by the general formula (1b).

To do this, we make the substitution in the force equation: $l = \Delta l_0$ и $l_я{}^3 = 3\Delta l_0^3 / 4\pi B$. Let's write the force as:

$$F_p = \frac{2}{3} l_я^2 \cdot \Delta p = \frac{M_{а.б} M_б G}{2\pi l_я{}^2} \left(\frac{l_я^3}{\Delta l_0{}^3} - 1\right) = \frac{M_{а.б} M_б G}{2\pi \Delta l_0{}^2 \left(\frac{3}{4\pi B}\right)^{\frac{2}{3}}} \cdot \left(\frac{\frac{3}{4\pi B} \Delta l_0^3}{\Delta l_0^3} - 1\right) = \frac{M_{а.б} M_б G}{2\pi \Delta l_0^2 \left(\frac{3}{4\pi B}\right)^{\frac{2}{3}}} \cdot \left(\frac{3}{4\pi B} - 1\right) > 0 \tag{19a}$$

From the formula, it is clear that the resulting force has acquired a positive sign, i.e., it has become a repulsive force. Thus, the emergence of the cosmological baryon number, or baryon charge, has led to the emergence of repulsion between the masses of antimatter and matter in the five-dimensional sphere. However, from the perspective of modern physics, the emergence of baryon number signifies the end of particle-antiparticle annihilation in three-dimensional space. So, with what, then, does the baryon mass interact gravitationally in the resulting formula?

The answer to this question can be found in the following reasoning. After spontaneous symmetry breaking, a resulting 3-dimensional volume was formed. A baryonic mass appeared at the center of the volume. The periphery of the volume was formed by an antibaryon mass-energy equal to the baryonic mass-energy. Both masses began to interact gravitationally within this volume. The volume arose within the space of a 5-dimensional sphere. A positive net force arose within the sphere. It began to act on the baryonic mass located at the center in the direction of the additional dimension, which was proper time. Under the action of this force, the baryonic mass began to move along the specified axis in the positive direction, expanding the 3-dimensional volume. The internal baryonic time formed within the volume turned out to be dependent on the external proper time.

Let's consider how the mass-energy of antimatter behaves from the perspective of a gravitational 3-dimensional volume. The gravitational force can be written as:

$$F_{гр} = -\frac{M_{а.б}\cdot M_{б}G}{l^2} = -\frac{M_{а.б}c^2}{l^2}\cdot\frac{M_{б}G}{c^2} = -\frac{M_{а.б}c^2\cdot}{l^2}P_{б} = -\frac{M_{а.б}c^2}{\frac{l^2}{P_{б}}} = -\frac{M_{а.б}c^2}{s} \qquad (19b)$$

Where $-s = l^2 / P_{б}$ - parabolic proper time function:

$P_{б} = M_{б}G / c^2$ - gravitational radius of the baryonic mass.

The formula shows that the mass-energy of antimatter moves in the opposite direction of the proper time axis along a parabola from the perspective of an observer in 3-dimensional space. The observer as a vacuum perceives this backward motion.

Nobel laureate Richard Feynman created quantum electrodynamics [4 p. 90], according to which a positron is an electron moving in reverse time. Therefore, the author's result only confirms this theory, but at the macro level.

From the above, we can draw the following conclusion: An observer composed of baryonic matter sees around him an expanding 3-dimensional space in the form of a vacuum formed by antimatter moving in reverse time, and does not observe this antimatter in its pure form.

Let's consider what happens to masses in a 5-dimensional sphere. To do this, we'll consider the derivation for the resultant force . Given the initial value , we have a time shift equal to:

$$s_0 = \frac{\Delta l_0^{\ 2}}{P_{б}} \qquad (20)$$

Substituting into the formula for the resulting force (1b), we obtain:

$$F_{0p} = \frac{F_{0гр}}{2\pi l_{я}^{\ 2}}\left(\frac{\Delta l_0^{\ 3} - l_{я}^3}{\Delta l_0}\right) = \frac{M_{а.б}\cdot M_{б}G}{2\pi l_{я}^{\ 2}\Delta l_0^2}\cdot\left(\frac{l_{я}^3 - \Delta l_0^{\ 3}}{\Delta l_0}\right) = \frac{M_{б}c^2}{\frac{\Delta l_0^2}{P_{б}}\cdot 2\pi l_{я}^{\ 2}}\cdot\left(\frac{l_{я}^3 - \Delta l_0^{\ 3}}{\Delta l_0}\right) = \frac{M_{б}c^2}{2\pi l_{я}^{\ 2} s_0}\cdot\left(\frac{l_{я}^3}{\Delta l_0} - \Delta l_0^{\ 2}\right) = \frac{M_{б}c^2}{2\pi s_0}\cdot\left(\frac{l_{я}}{\Delta l_0} - \frac{\Delta l_0^{\ 2}}{l_{я}^{\ 2}}\right)$$

Let's continue transforming the force formula:

$$F_{0p} = \frac{2}{3}l_{я}^2(\rho_{пр} - \rho_{я})c^2 = \frac{M_{б}\bar{c}^2}{2\pi s_0}\cdot\left(\frac{l_{я}}{\Delta l_0} - \frac{\Delta l_0^{\ 2}}{l_{я}^{\ 2}}\right) = -\frac{F_{0гр}}{2\pi}\cdot\left(\sqrt[3]{\frac{3}{4\pi B}} - \frac{1}{\left(\frac{3}{4\pi B}\right)^{\frac{2}{3}}}\right) = \frac{F_{0гр}}{2\pi}\cdot\left(\frac{3}{4\pi B}\right)^{\frac{1}{3}}\left(1 - \frac{4\pi B}{3}\right) > 0 \qquad (21)$$

Whare $\frac{l_{я}}{\Delta l_0} = \left(\frac{3}{4\pi B}\right)^{\frac{1}{3}}$

It follows that the force in the sphere acts on the baryon mass-energy along the positive axis of its proper time.

Thus, we arrived at a formula for the resultant force, which moves the total energy of matter along the positive axis , taking into account the baryon number.

A change along the axis means that time "flows" from the past to the future. The flow of time leads to a corresponding change in baryon time in the volume Δl^3, which increases, and therefore represents the spatial expansion of the Metagalaxy.

Let's consider whether baryon number influences the gravitational force in a 3-dimensional volume. Let's express the gravitational force from (21).

$$-F_{0гр} = \frac{1}{(\frac{3}{4\pi B})^{\frac{1}{3}}(1-\frac{4\pi B}{3})}\frac{4\pi}{3}l_я^2(\rho_{0б} - \rho_{0а.м.})c^2 \qquad (22)$$

In the formula we take,

test mass density as baryon $\rho_{пр} = \rho_{0б} = M_б / \frac{4}{3}\pi\Delta l_0^3$,

core density as the density of antimatter $\rho_я = \rho_{0а.б.} = M_{а.б.} / \frac{4}{3}\pi l_я^3$.

Substituting, we get:

$$-F_{0гр} = \frac{1}{(\frac{3}{4\pi B})^{\frac{1}{3}}(1-\frac{4\pi B}{3})}\frac{4\pi}{3}l_я^2(\frac{M_б}{\frac{4}{3}\pi\Delta l_0^3} - \frac{M_{а.б.}}{\frac{4}{3}\pi l_я^3})c^2 = \frac{1}{(1-\frac{4\pi B}{3})}\frac{4\pi}{3}\Delta l_0^2(\frac{3}{4\pi B})^{\frac{1}{3}}(\frac{M_б}{\frac{4}{3}\pi\Delta l_0^3} - \frac{M_{а.б.}}{\frac{4}{3}\pi l_я^3})c^2 \qquad (23)$$

Where $l_я{}^2 = \Delta l_0^2(\frac{3}{4\pi B})^{\frac{2}{3}}$ (см. (14d))

It follows from the formula that the gravitational force in three-space is related to the baryon number. This suggests that the baryon and antibaryon masses should annihilate with each other. However, this assumption is incorrect. We will show that annihilation does not occur, and the masses react gravitationally with each other in three-space. To do this, we continue the force transformation (23).

$$-F_{0гр} = \frac{1}{(1-\frac{4\pi B}{3})}\frac{4\pi}{3}\Delta l_0^2(\frac{3}{4\pi B})^{\frac{1}{3}}\frac{M_б}{\frac{4}{3}\pi\Delta l_0^3}(1-\frac{M_{а.б.}4\pi B}{M_б 3})c^2 = \frac{1}{(1-\frac{4\pi B}{3})}\frac{l_я}{\Delta l_0}\cdot\frac{M_б}{\Delta l_0}(1-\frac{M_{а.б.}4\pi B}{M_б 3})c^2$$

Because $M_{а.м} = M_б$ и $l_я = \frac{M_{а.м.}G}{c^2} = \frac{M_б G}{c^2}$, then you can write:

$$-F_{0гр} = \frac{1}{(1-\frac{4\pi B}{3})}\frac{l_я}{\Delta l_0}\cdot\frac{M_б}{\Delta l_0}(1-\frac{M_{а.м.}4\pi B}{3M_б})c^2 == \frac{1}{(1-\frac{4\pi B}{3})}\frac{M_{а.м.}\cdot M_б G}{\Delta l_0^2}\cdot(1-\frac{4\pi B}{3}) = \frac{M_{а.м.}\cdot M_б G}{\Delta l_0^2}$$

Thus, we arrived at the previous formula (16). It can now be interpreted as a gravitational spatial force acting between the masses of matter and antimatter, with the distance between them equal to the initial radius of the 3-dimensional sphere formed as a result of the annihilation of spatial energies. This distance prevents annihilation between the masses.

However, baryon number does influence processes in three-dimensional space, as it determines the magnitude of the baryon charge between particles and antiparticles, which are created from the vacuum by the impact of positive energy on it, as well as in certain decay processes between elementary particles. To understand these processes, let's consider how the cosmological baryon number is defined in physics. By definition, the cosmological baryon number is the ratio of the difference in baryon and antibaryon concentrations to the photon concentration:

$$B = \frac{n_б - n_{а.б.}}{n_\gamma} \qquad (24)$$

We introduce the definition of formulas for the concentration of the specified particles:

$n_б = \frac{1}{\frac{4}{3}\pi\Delta l_0^3}$ - concentration of baryons per unit volume

$n_{а.б} = \frac{1}{\frac{4}{3}\pi l_я^3}$ - concentration of antibaryons per unit volume.

Taking them into account, the gravitational force (23) will take the form with equal masses.

$$-F_{0гр}=\frac{1}{(1-\frac{4\pi B}{3})}\frac{4\pi}{3}\Delta l_0^2(\frac{3}{4\pi B})^{\frac{1}{3}}M_б c^2(\frac{1}{\frac{4}{3}\pi\Delta l_0^3}-\frac{1}{\frac{4}{3}\pi l_я^3})=\frac{1}{(1-\frac{4\pi B}{3})}\cdot\frac{4\pi}{3}\Delta l_0^2\frac{l_я}{\Delta l_0}\cdot M_б c^2(n_б-n_{a.б})=\frac{1}{(1-\frac{4\pi B}{3})}\cdot\frac{4\pi}{3}\Delta l_0\cdot l_я\cdot M_б c^2(n_б-n_{a.б}) \quad (25)$$

As we see, the force is expressed through the required difference in particle concentrations, but does not include the photon concentration. It can be determined from (24).

$$n_\gamma=\frac{n_б-n_{a.б.}}{B}=(\frac{1}{\frac{4}{3}\pi\Delta l_0^3}-\frac{1}{\frac{4}{3}\pi l_я^3})\frac{1}{B}=(\frac{l_я^3-\Delta l_0^3}{l_я^3\cdot\Delta l_0^3})\cdot\frac{1}{\frac{4}{3}\pi B} \quad (26a)$$

Where:

the product of volumes is equal to:

$$\Delta l_0{}^3\cdot l_я{}^3=\frac{4\pi}{3}BP_б^3\cdot\frac{3}{4\pi B}\Delta l_0{}^3=P_б^3\cdot\Delta l_0{}^3=P_б^3\cdot\frac{4\pi}{3}BP_б^3=\frac{4\pi}{3}BP_б^6$$

the difference in volumes is equal to:

$$l_я{}^3-\Delta l_0{}^3=\frac{3}{4\pi B}\Delta l_0{}^3-\frac{4\pi}{3}BP_б^3=\frac{3}{4\pi B}\cdot\frac{4\pi}{3}BP_б^3-\frac{4\pi}{3}BP_б^3=\frac{4\pi}{3}BP_б^3(\frac{3}{4\pi B}-1)$$

Substituting into the formula for n_γ, we obtain:

$$n_\gamma=(\frac{l_я^3-\Delta l_0^3}{l_я^3\cdot\Delta l_0^3})\cdot\frac{1}{\frac{4}{3}\pi B}=\frac{\frac{4\pi}{3}BP_б^3(\frac{3}{4\pi B}-1)}{\frac{4\pi}{3}BP_б^6}\cdot\frac{1}{\frac{4}{3}\pi B}=\frac{(\frac{3}{4\pi B}-1)}{P_б^3}\cdot\frac{1}{\frac{4}{3}\pi B}=\frac{(\frac{3}{4\pi B}-1)}{\frac{4}{3}\pi BP_б^3}=\frac{(1-\frac{4\pi B}{3})}{\frac{16\pi^2}{9}B^2P_б^3}$$

The resulting formula for photon concentration can be expressed through the area of a 5-dimensional sphere:

$$n_\gamma=\frac{(1-\frac{4\pi B}{3})}{\frac{16\pi^2}{9}B^2P_б^3}=\frac{3P_б}{2}\cdot\frac{(1-\frac{4\pi B}{3})}{\frac{8\pi^2}{3}B^2P_б^4} \quad (26b)$$

We substitute the found value of photon concentration into the formula of gravitational force (25), transforming it to the form:

$$-F_{0гр}=\frac{1}{(1-\frac{4\pi B}{3})}\cdot\frac{4\pi}{3}\Delta l_0\cdot l_я\cdot M_б(n_б-n_{a.б})c^2=\frac{1}{(1-\frac{4\pi B}{3})}\frac{4\pi}{3}\Delta l_0\cdot l_я\cdot M_б c^2(\frac{n_б-n_{a.б}}{n_\gamma})n_\gamma=\frac{1}{(1-\frac{4\pi B}{3})}\cdot\frac{4\pi}{3}\Delta l_0\cdot l_я\cdot M_б c^2Bn_\gamma$$

Then we get at $l_я=P_б$:

$$-F_{0гр}=\frac{1}{(1-\frac{4\pi B}{3})}\cdot\frac{4\pi}{3}\Delta l_0\cdot l_я\cdot M_б c^2Bn_\gamma=\frac{1}{(1-\frac{4\pi B}{3})}\cdot\frac{4\pi}{3}\Delta l_0\cdot l_я\cdot M_б c^2B\frac{(1-\frac{4\pi B}{3})}{\frac{16\pi^2}{9}B^2P_б^3}=\frac{4\pi}{3}\Delta l_0\cdot l_я\cdot\frac{M_б c^2}{\frac{16\pi^2}{9}BP_б^3}=\frac{4\pi}{3}\Delta l_0\cdot l_я\cdot\frac{M_б c^2}{\frac{4}{3}\pi\cdot\Delta l_0^3}$$

Where:

$$\frac{16\pi^2}{9}BP_б^3=\frac{4}{3}\pi\cdot\frac{4}{3}\pi Bl_я{}^3=\frac{4}{3}\pi\cdot\Delta l_0^3;\ \rho_{0б}=\frac{M_б}{\frac{4\pi}{3}\Delta l_0^3}$$

Then the gravitational force can be written as:

$$-F_{0гр} = \frac{1}{(1-\frac{4\pi B}{3})} \cdot \frac{4\pi}{3} \Delta l_0 \cdot l_я \cdot M_б c^2 B n_\gamma = \frac{4\pi}{3} \Delta l_0 \cdot M_{а.м.} G \cdot \rho_{0б} = \Delta l_0 \cdot M_{а.м.} \frac{4\pi}{3} G \cdot \rho_{0б} = \Delta l_0 \cdot K_{пр} \quad (27)$$

Where:

$$K_{пр} = M_{а.б.} \frac{4\pi}{3} G \cdot \rho_{0б} = M_{а.б.} \frac{1}{3} \cdot \frac{4\pi G \cdot \rho_{0б} c^2}{c^2} = M_{а.б.} \frac{1}{3} \cdot \Lambda_б c^2 = M_{а.б.} \Omega_б^2$$

Where:

$\Lambda_{0б} = \frac{4\pi G \cdot \rho_{0б}}{c^2}$ there is an analogue of the cosmological constant for baryonic matter;

$\frac{1}{3} \cdot \Lambda_б c^2 = \Omega_б^2$ is the square of the initial angular velocity of rotation for baryonic matter;

$K_{пр}$ is the initial coefficient of elasticity of 3-space.

Then the initial gravitational force is the initial elastic force and can be written as:

$$F_{0гр} = -K_{пр} \cdot \Delta l_0 \quad (28)$$

The formula for the initial gravitational force is identical in form to Hooke's law.

However, the introduced quantities, unlike the 3-vacuum formed by the mass-energy of antimatter, are not constant. They depend on baryon time and change over that time.

The coefficient of elasticity of space can be written taking into account the left part of the obtained formula (27) in the form:

$$K_{пр} = \frac{1}{(1-\frac{4\pi B}{3})} \cdot \frac{4\pi}{3} \cdot l_я \cdot M_б c^2 B n_\gamma = \frac{B}{(1-\frac{4\pi B}{3})} \cdot \frac{4\pi}{3} \cdot M_{а.б.} M_б G \cdot n_\gamma$$

As we can see, it depends on the photon concentration. Let us consider the elasticity coefficient from a physical perspective. Substituting the photon concentration into the formula in the form (26b), we obtain:

$$K_{пр} = \frac{B}{(1-\frac{4\pi B}{3})} \cdot \frac{4\pi}{3} \cdot M_{а.б.} M_б G \cdot \frac{3P_б}{2} \cdot \frac{(1-\frac{4\pi B}{3})}{\frac{8\pi^2}{3} B^2 P_б^4} = M_{а.б.} M_б G \cdot \frac{3P_б}{2} \cdot \frac{1}{2\pi B P_б^4} = M_{а.б.} G \cdot \frac{M_б}{\frac{4\pi}{3} B P_б^3} = \frac{M_{а.б.} M_б G}{\Delta l_0^3}$$

As we can see, elasticity is analogous to the gravitational force in 4-dimensional space. Its magnitude is determined by the Ehrenfest formula [5].

This result proves that 3-space is located within 4-dimensional space and acts as an elastic "body" for it. The analog of 4-space is a 5-dimensional sphere.

Acting on this "body" with the 4-force $K_{пр}$, the sphere causes elastic deformation, which generates the gravitational force in 3-space. This interaction is schematically depicted in Figure 3.

As we can see, elasticity is an analogue of gravitational force in 4-dimensional space. Its magnitude is determined by the Ehrenfest formula [5].

It conventionally depicts a 5-dimensional sphere in three spatial coordinates $l_я$, which has one spatial dimension more than the 3-dimensional spherical volume that represents our Metagalaxy and is conventionally depicted in two spatial coordinates l.

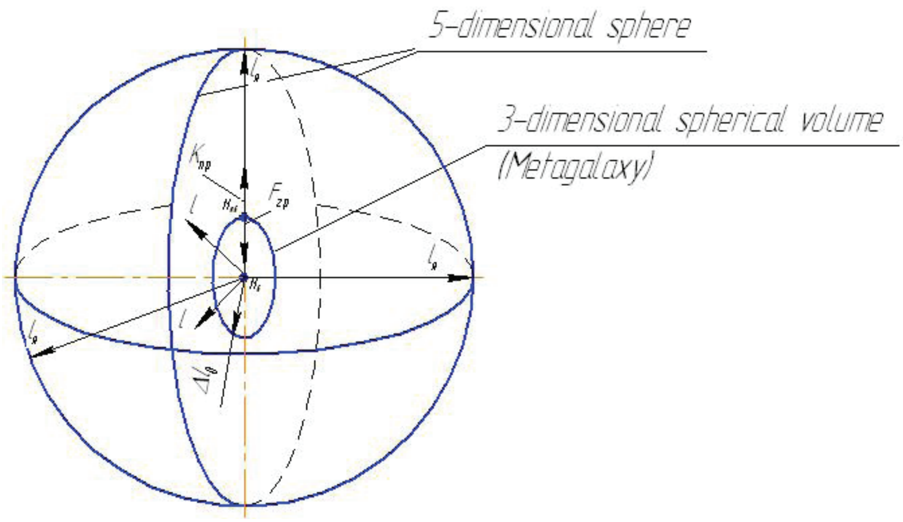

Fig. 4 Interaction of a 3-dimensional volume with a 5-dimensional sphere.

5. Conclusion

The mathematical approach presented in the article is based on Newton's formula for the gravitational force related to the space of a 5-dimensional sphere. It has proven fruitful in explaining the baryon asymmetry of the Universe. It allowed us to understand the cause of spontaneous symmetry breaking, determine the value of the cosmological baryon number, and explain the absence of antimatter in the Universe. The generalized formula for the gravitational force used here is the final link connecting gravitational processes in the Universe. The Friedmann equation, which follows from it, turns out to be incomplete. The time Friedman used to solve the equation is a linear quantity and is not related to general nonlinear time. Therefore, his models of non-stationary universes are incomplete and raise many questions, both physical and philosophical.

The author hopes that the results presented in the article will contribute to the further progress of modern cosmology.

Conflict of Interest:

This work was completed by the author alone at the request of the editors of the journal, based on personal scientific works: [1,2]. It uses literary sources from open databases, therefore permission for their publication is not required.

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